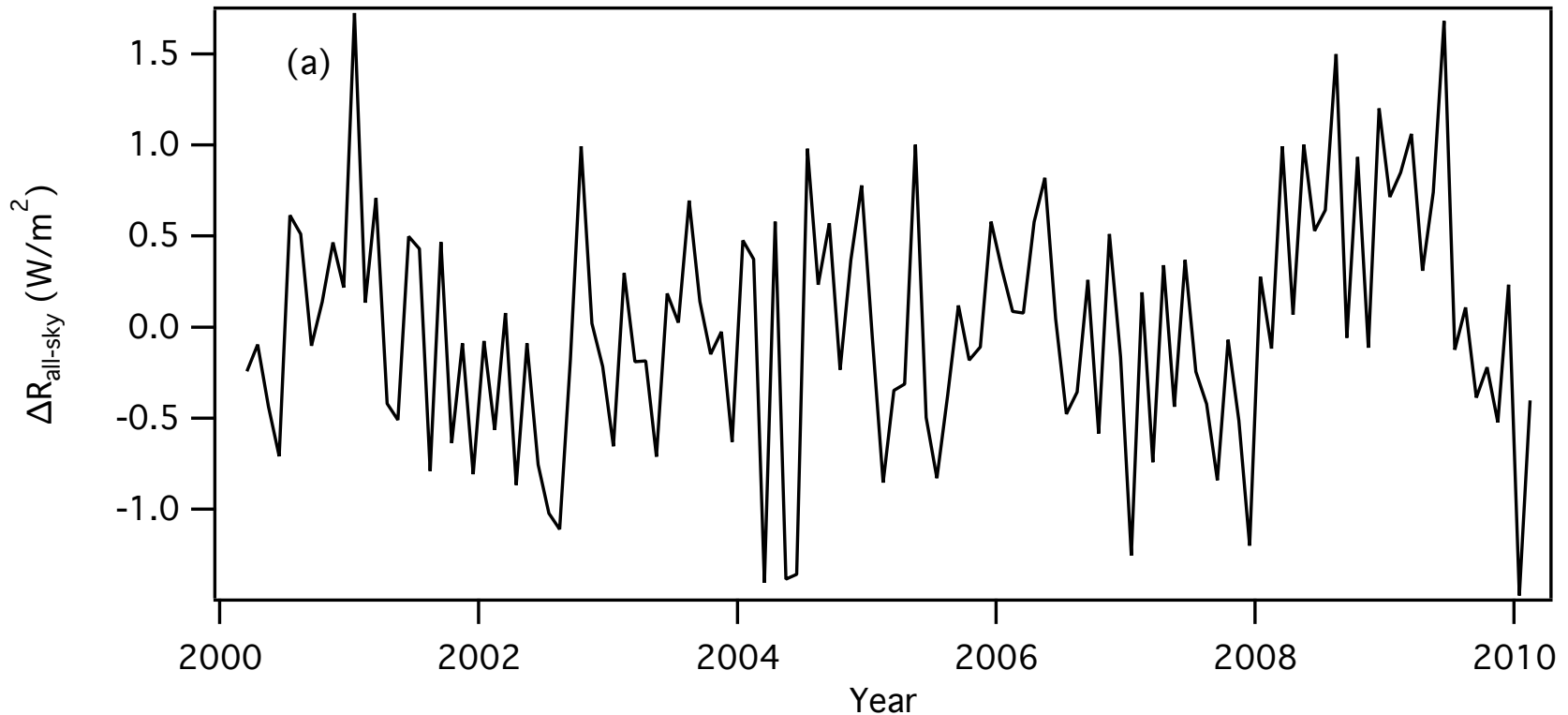


Drilling into the cloud feedback

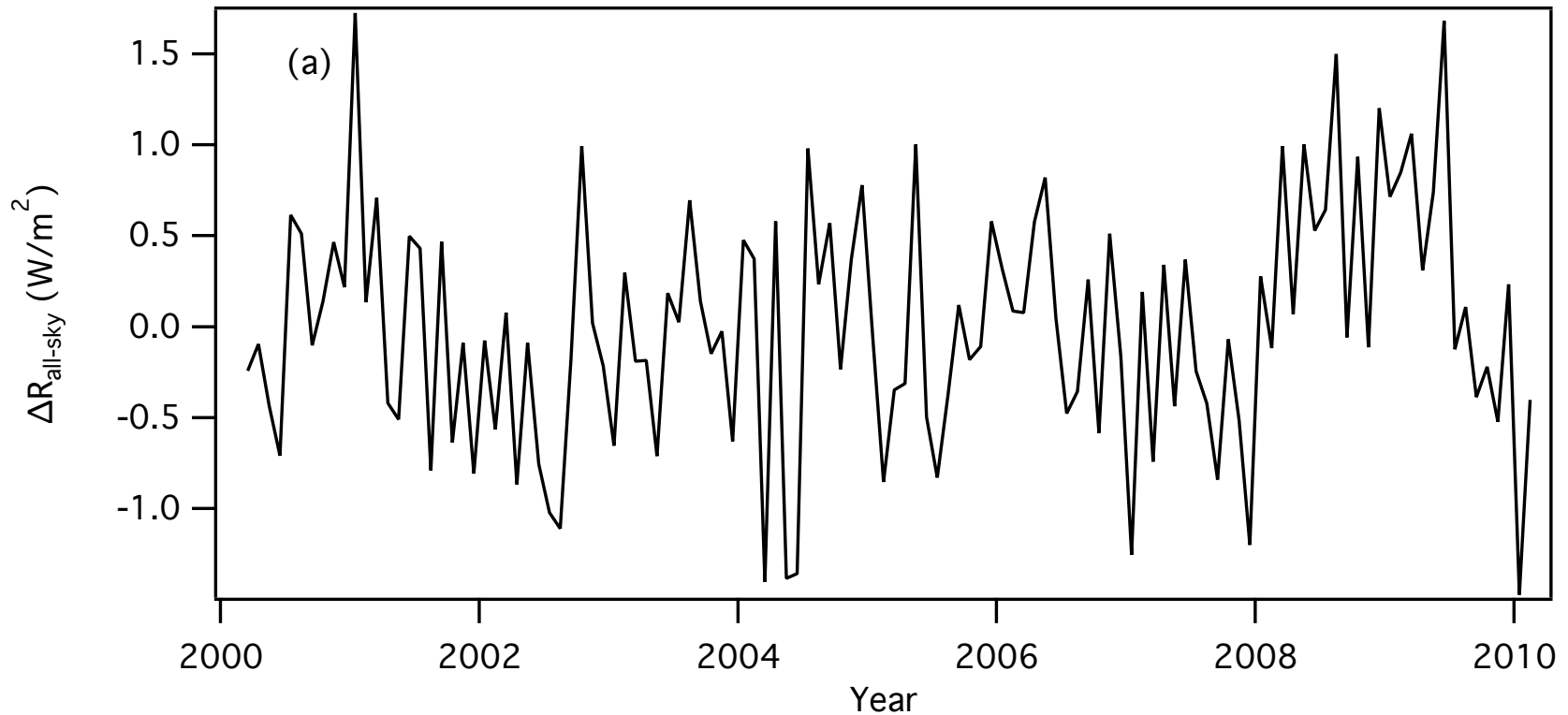
C. Zhou, A. E. Dessler, P. Yang
Department of Atmospheric Sciences
Texas A&M University

CERES top-of-atmosphere (TOA) net flux
SSF, 1-deg monthly avg., Ed. 2.5
longwave + shortwave



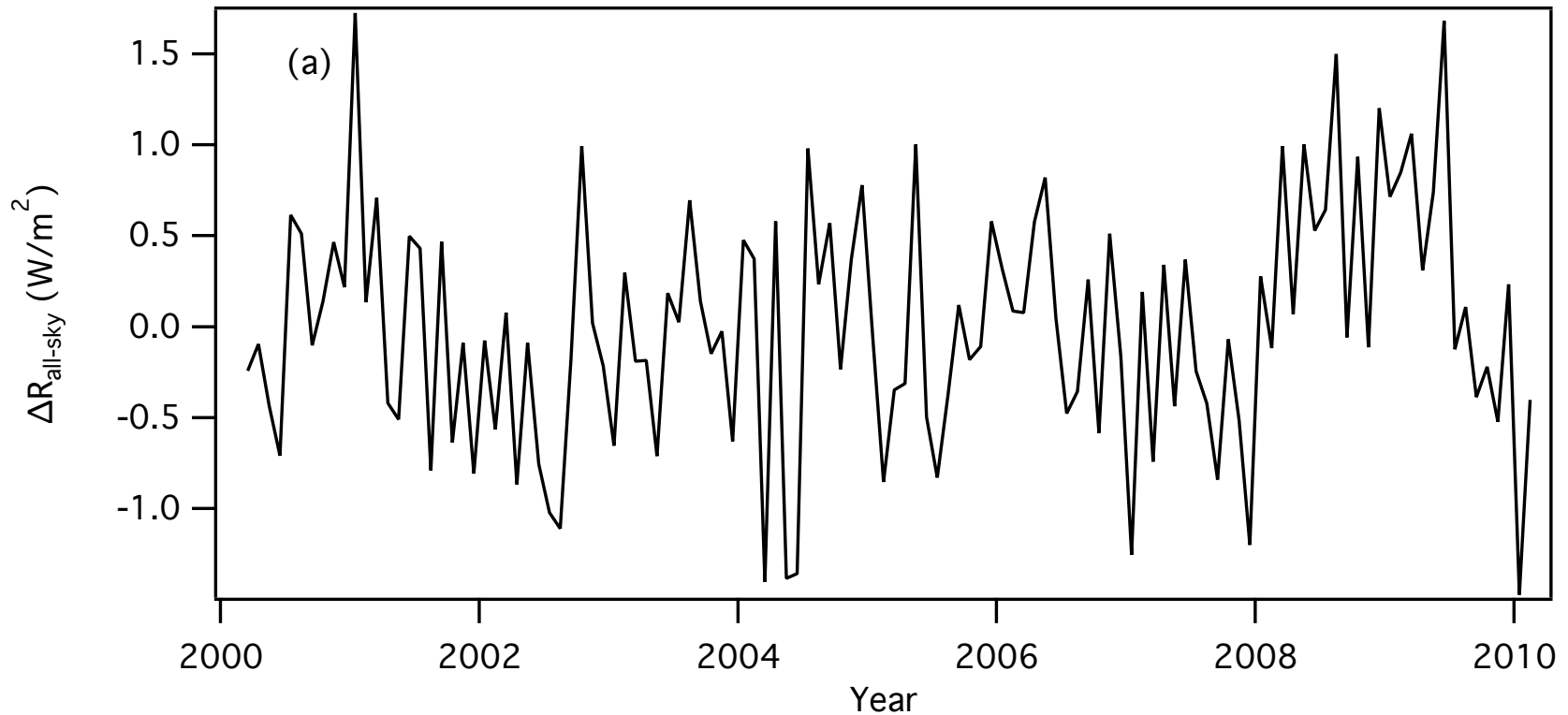
all fluxes in this analysis are downward positive
cover period 2/2000-12/2010

$$\Delta R_{\text{all-sky}} = \Delta R_T + \Delta R_q + \Delta R_{\text{albedo}} + \Delta R_{\text{cloud}} + \Delta F$$



$$\Delta R_{\text{cloud}} = \Delta \text{CRF} + \text{adjustments}$$

$$\Delta R_{\text{all-sky}} = \Delta R_T + \Delta R_q + \Delta R_{\text{albedo}} + \Delta R_{\text{cloud}} + \Delta F$$



$$\Delta R_{\text{cloud}} = \Delta \text{CRF} + \text{adjustments}$$





$$\text{CRF} = \Delta R_{\text{clear-sky}} - \Delta R_{\text{all-sky}}$$



$$\text{CRF} = \Delta R_{\text{clear-sky}} - \Delta R_{\text{all-sky}}$$

Reanalysis



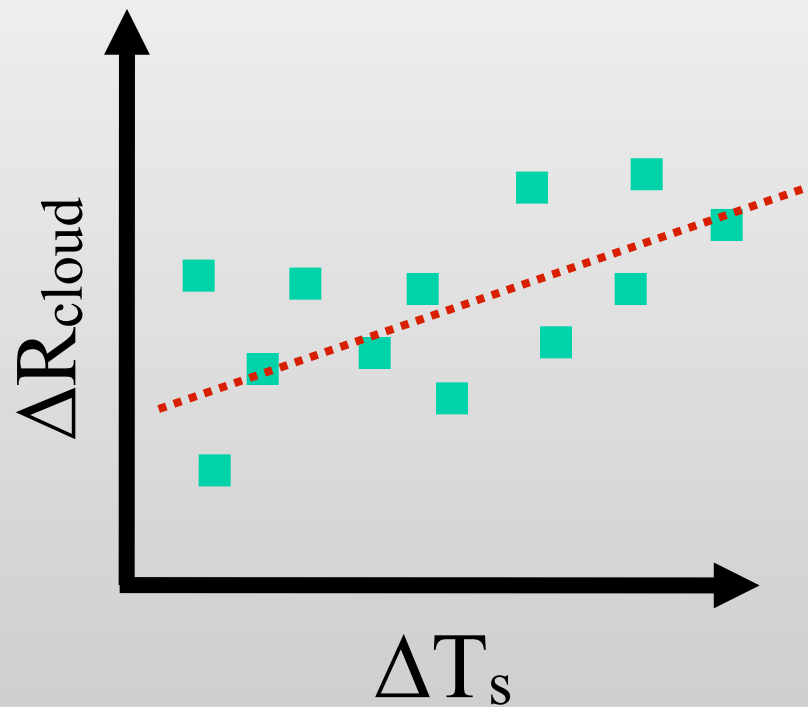
$$\text{CRF} = \Delta R_{\text{clear-sky}} - \Delta R_{\text{all-sky}}$$

Reanalysis

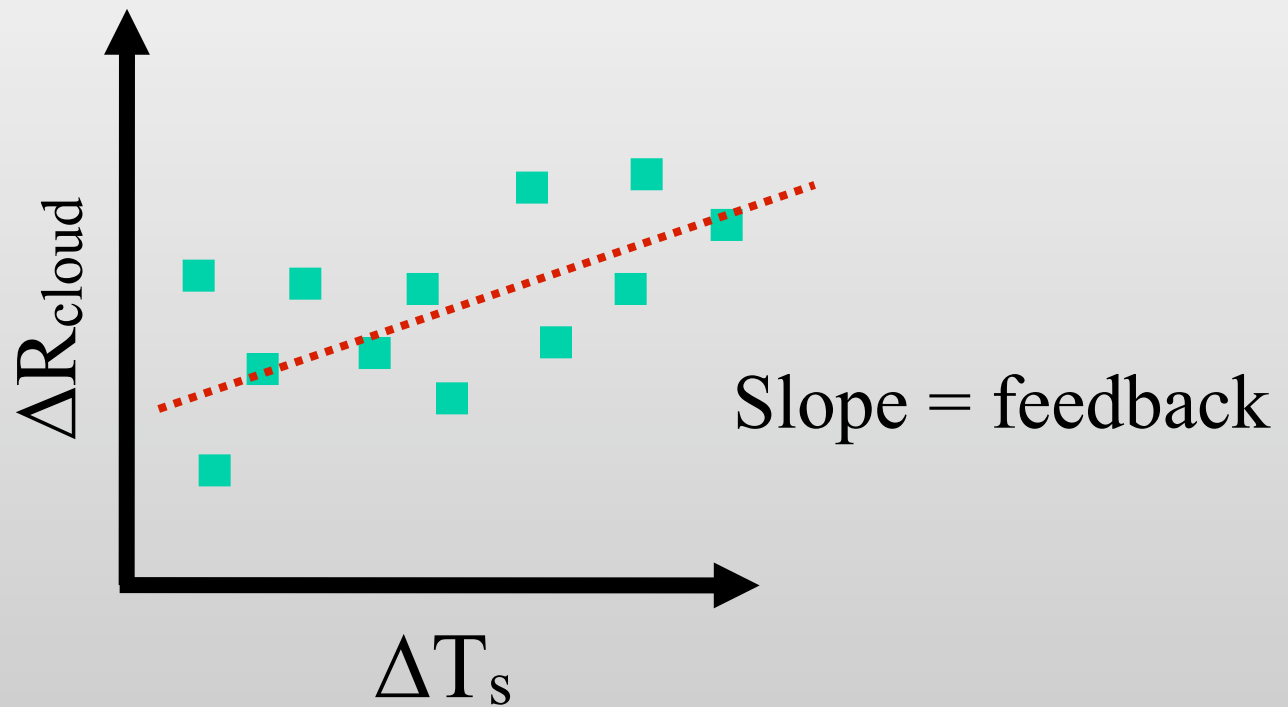
CERES

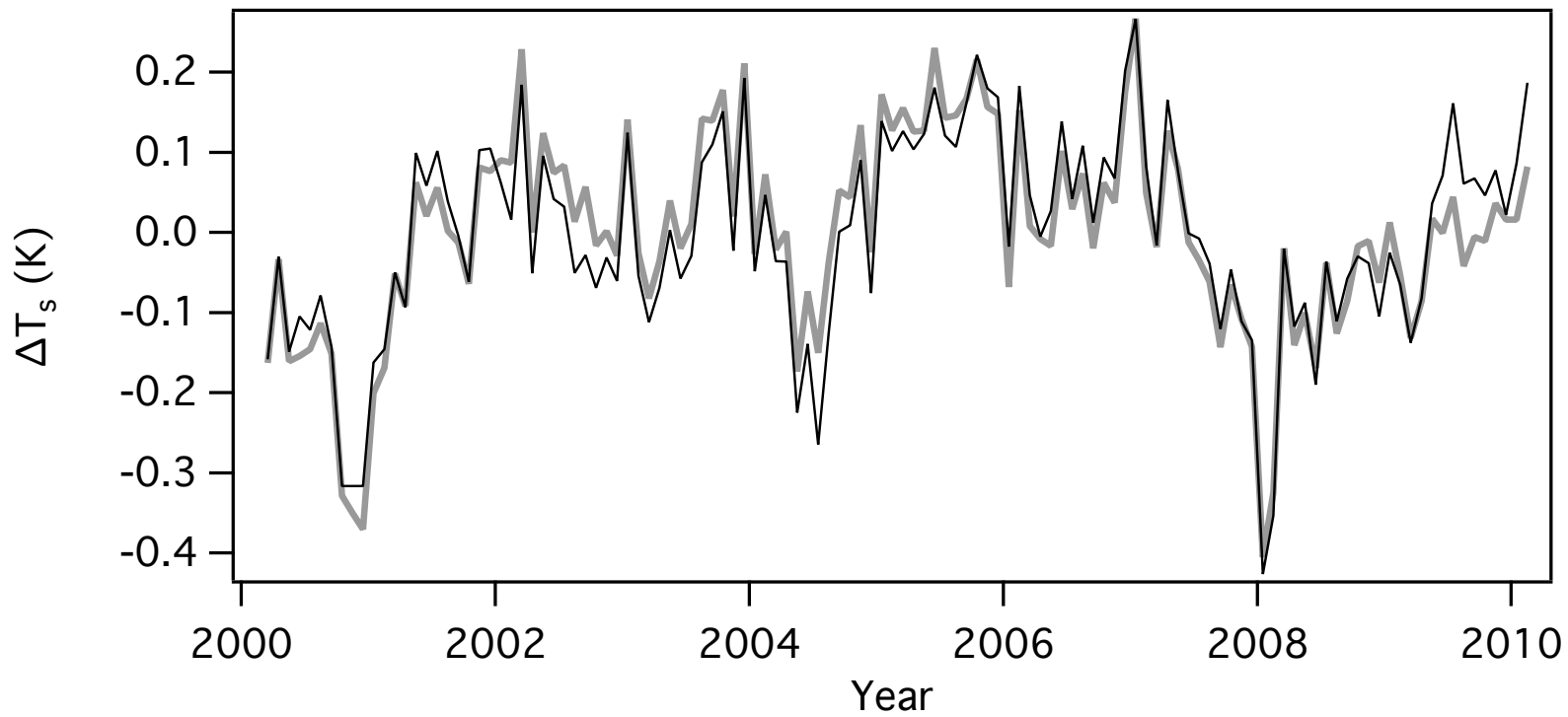


Regress CRF vs. surface temperature

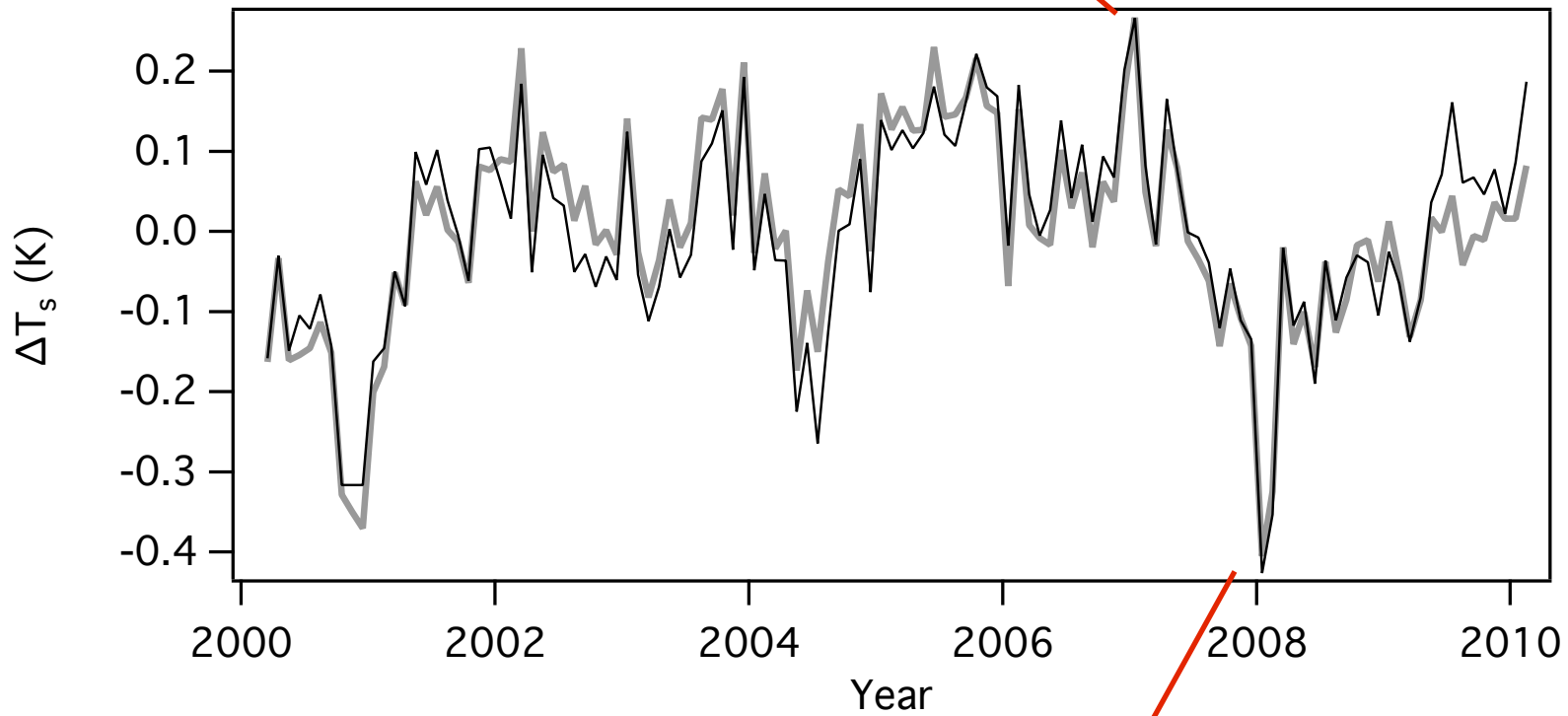


Regress CRF vs. surface temperature

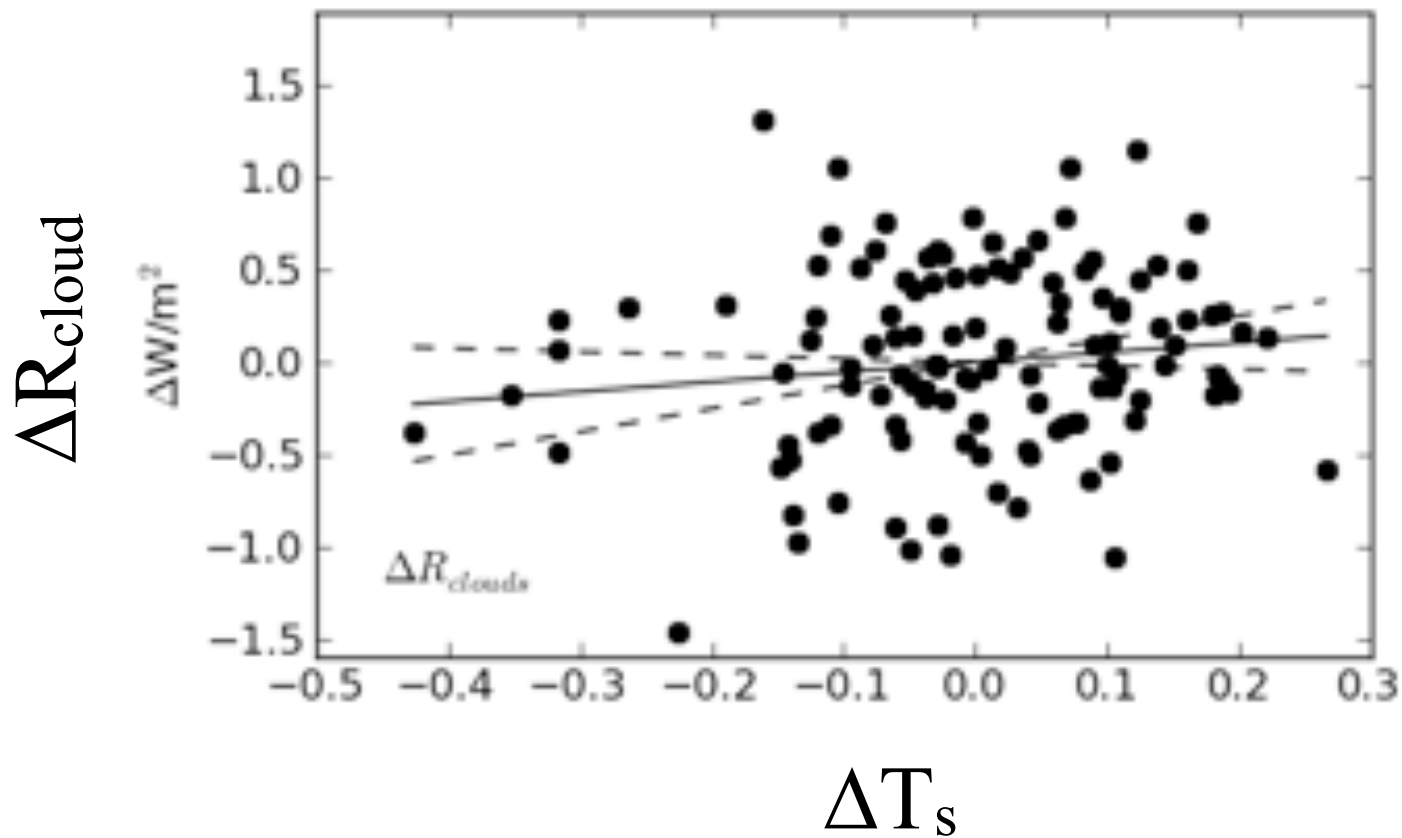




El Nino



La Nina

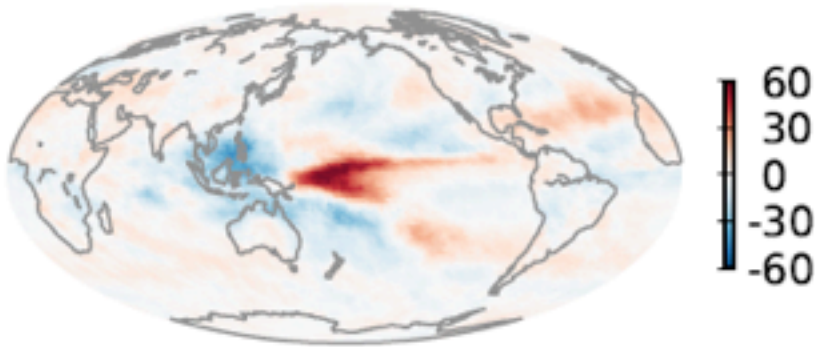


$$\text{cloud feedback} = \begin{array}{l} 0.49 \pm 0.69 \text{ W/m}^2/\text{K} \\ 0.58 \pm 0.70 \text{ W/m}^2/\text{K} \end{array}$$

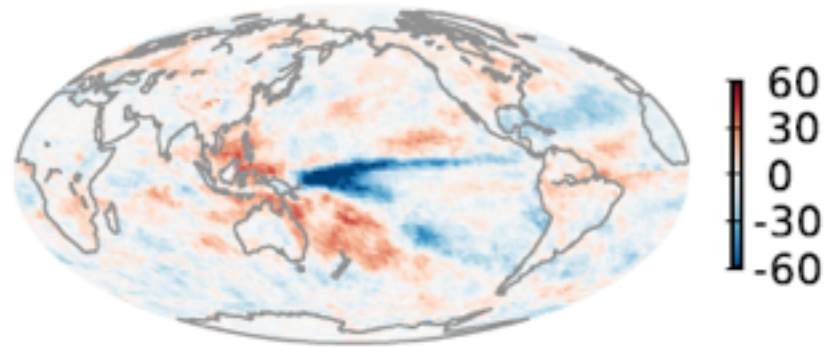
Dessler, *Science*, 2010

Observations

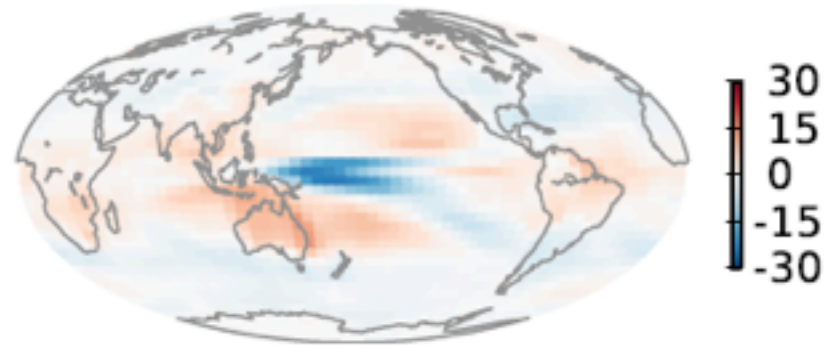
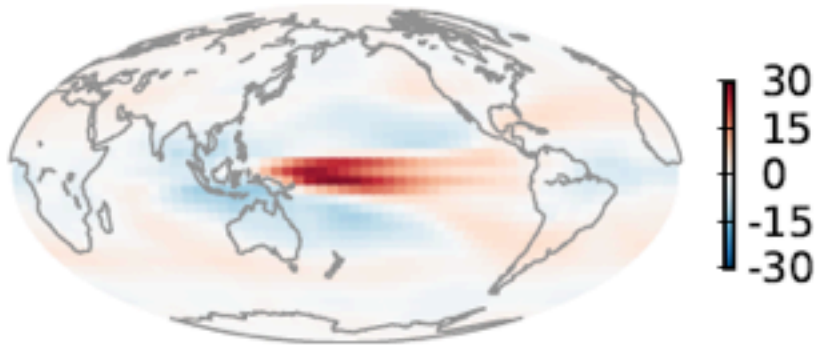
Longwave



Shortwave



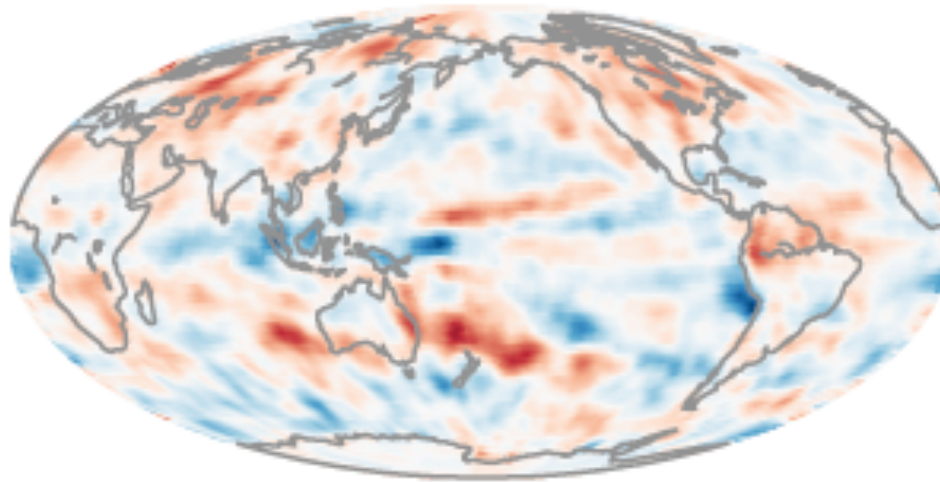
Control ensemble = avg. of 13 models



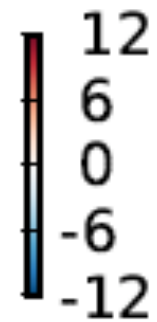
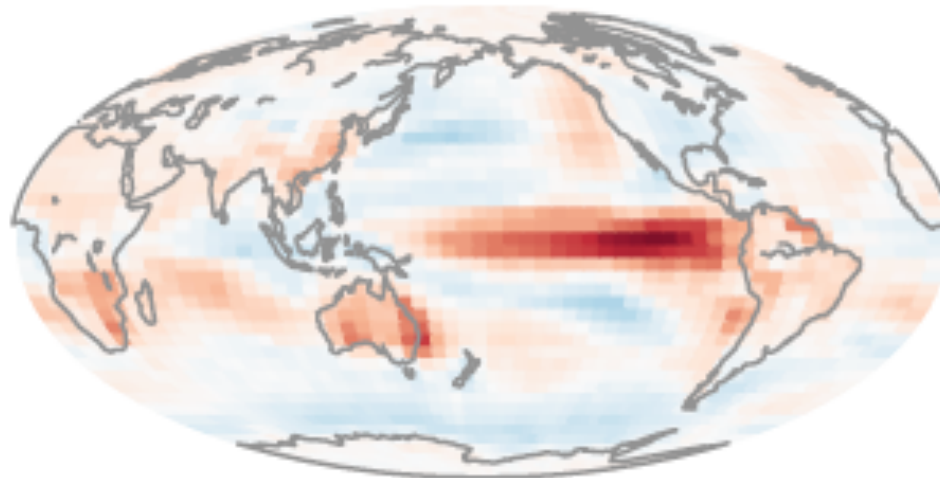
Each point is the regression slope of
 $\Delta R_{\text{cloud}}(\text{lat}, \text{lon})$ vs. global avg. ΔT_s
It is the local contribution to the global feedback

Total

obs.

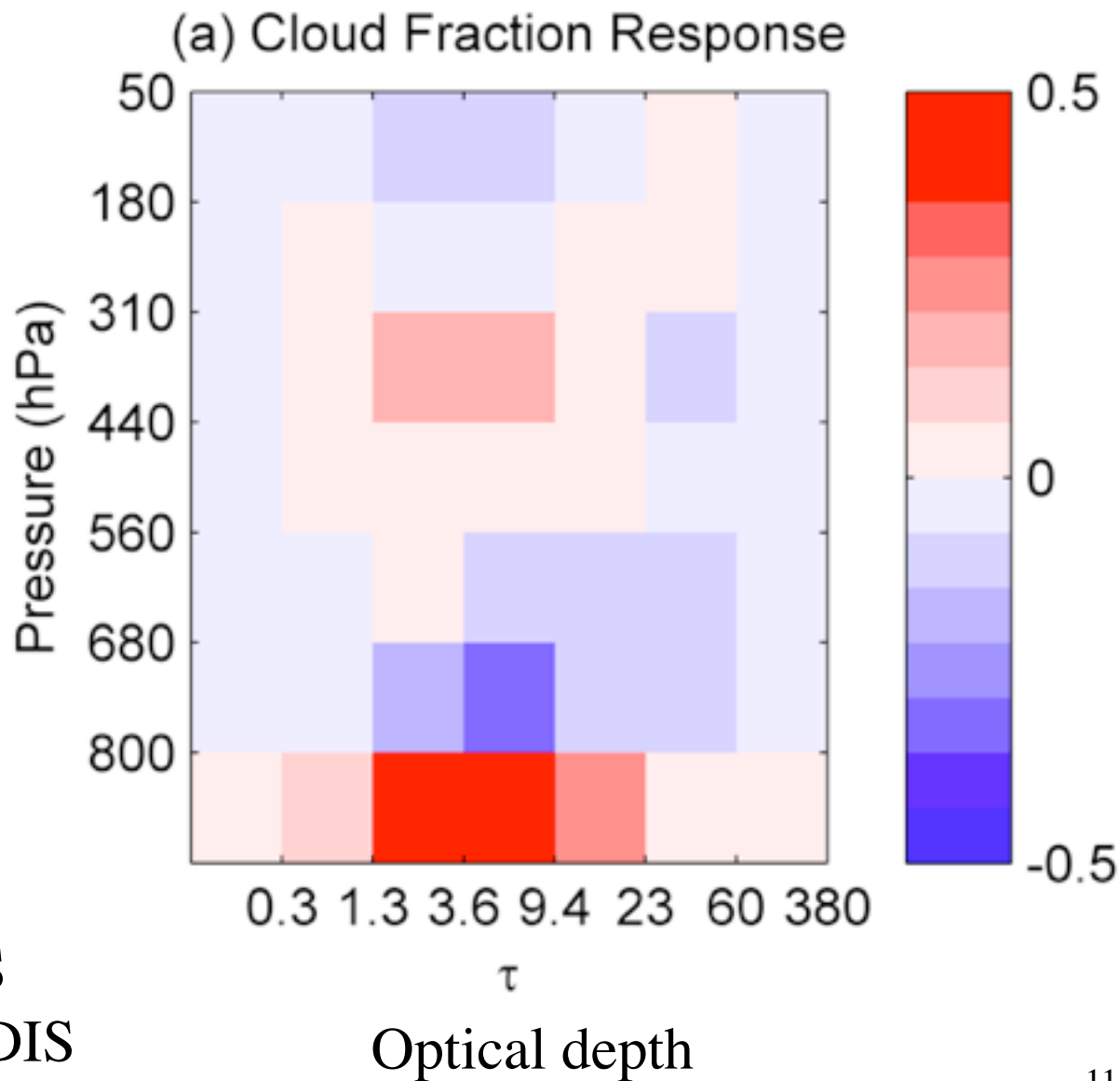


control



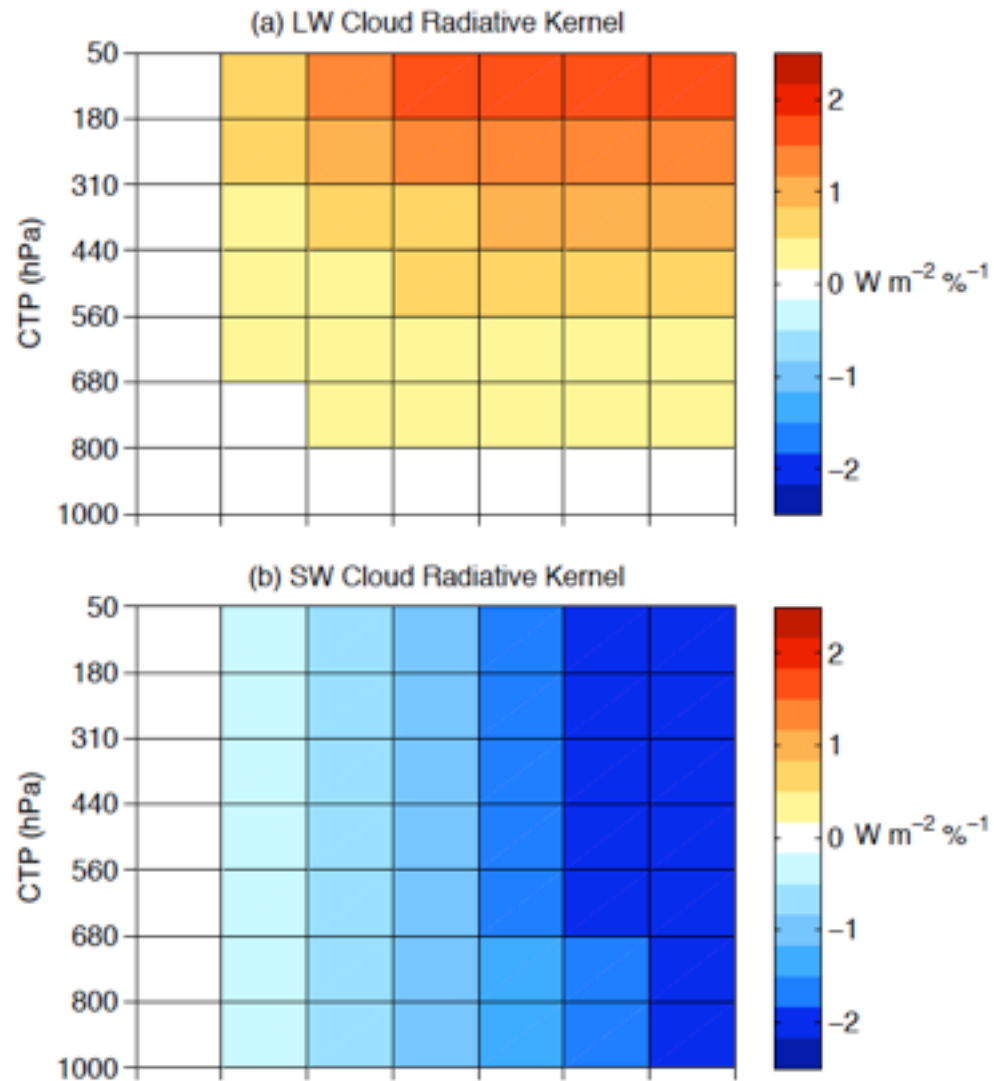
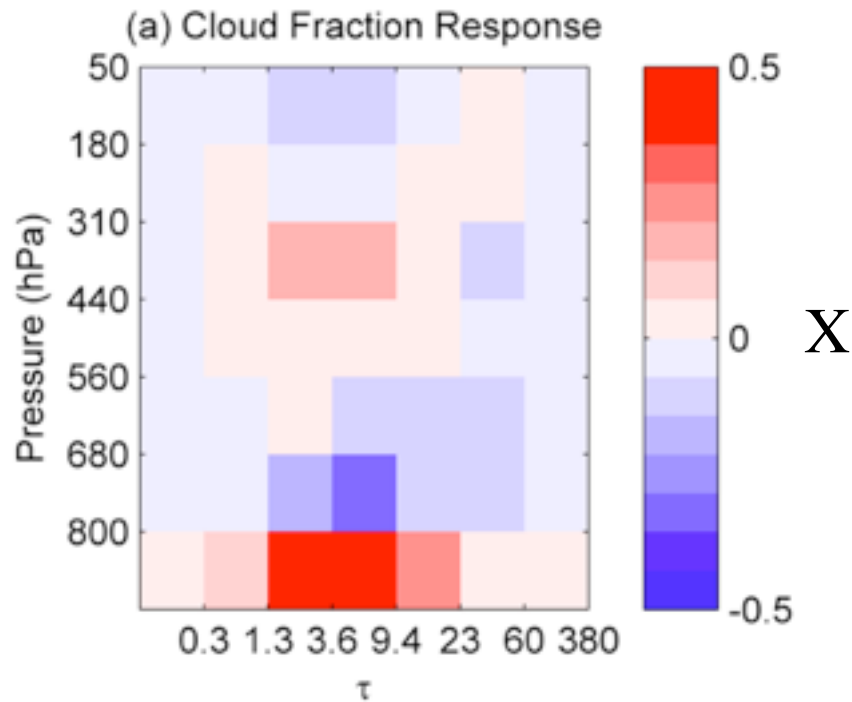
Calculations by
Chen Zhou

MODIS data (%/K)

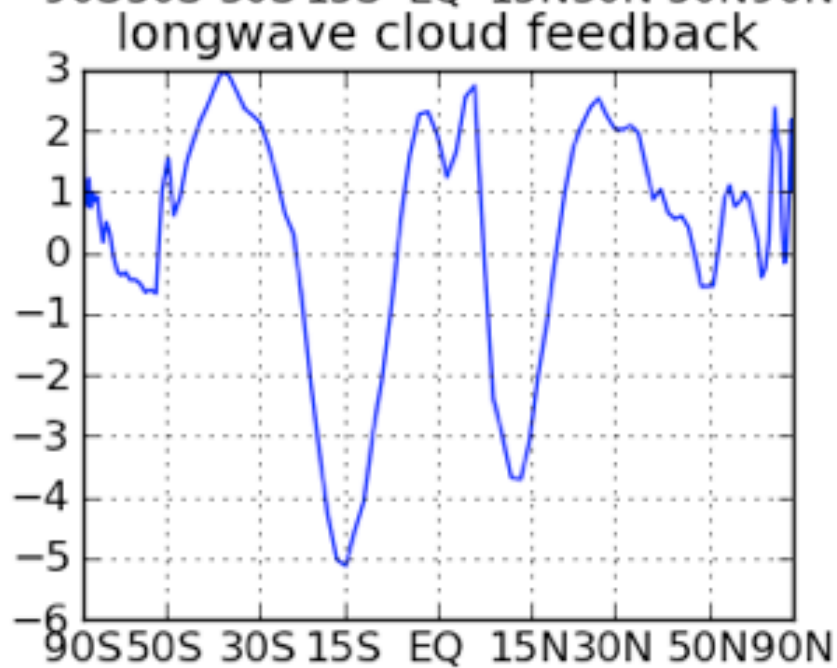
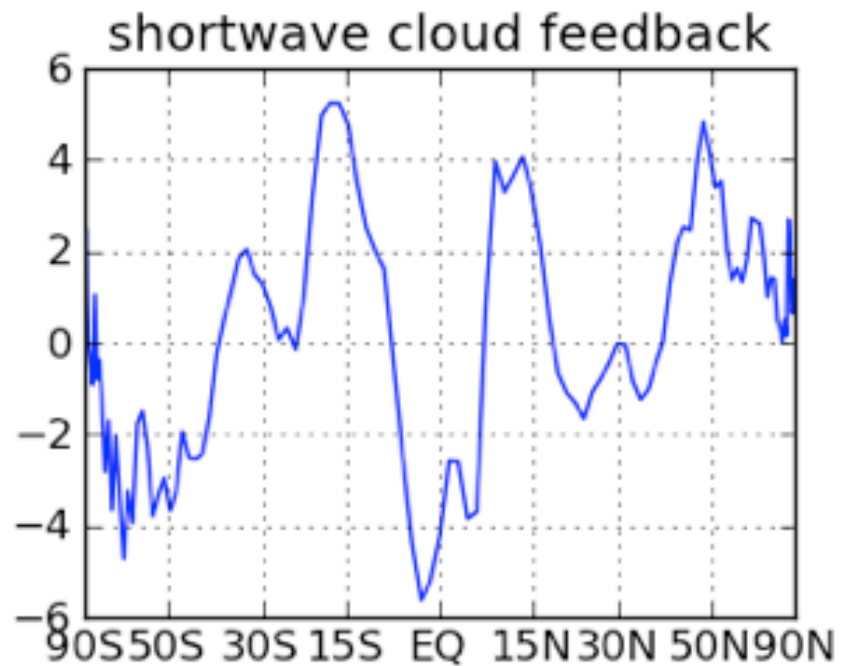
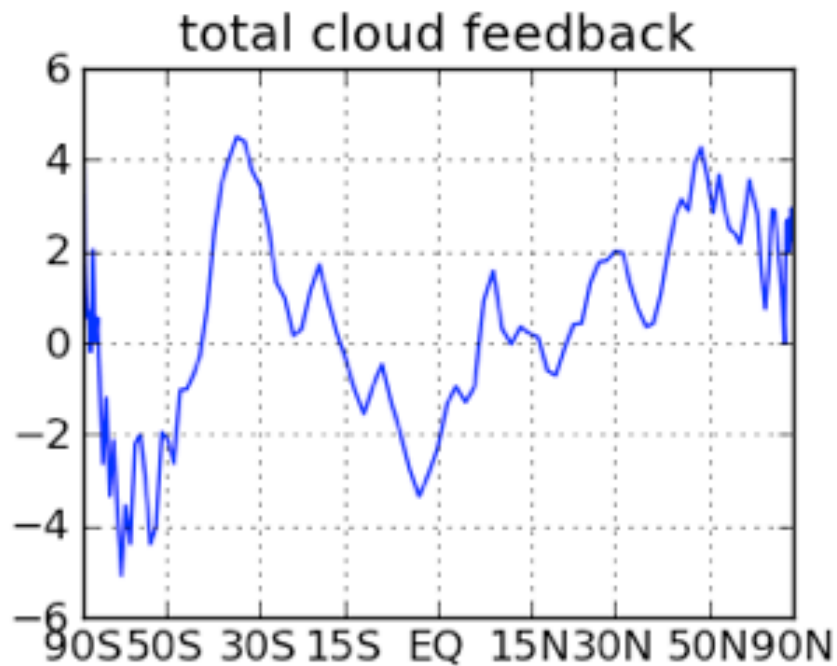


45°N-45°S
Terra MODIS



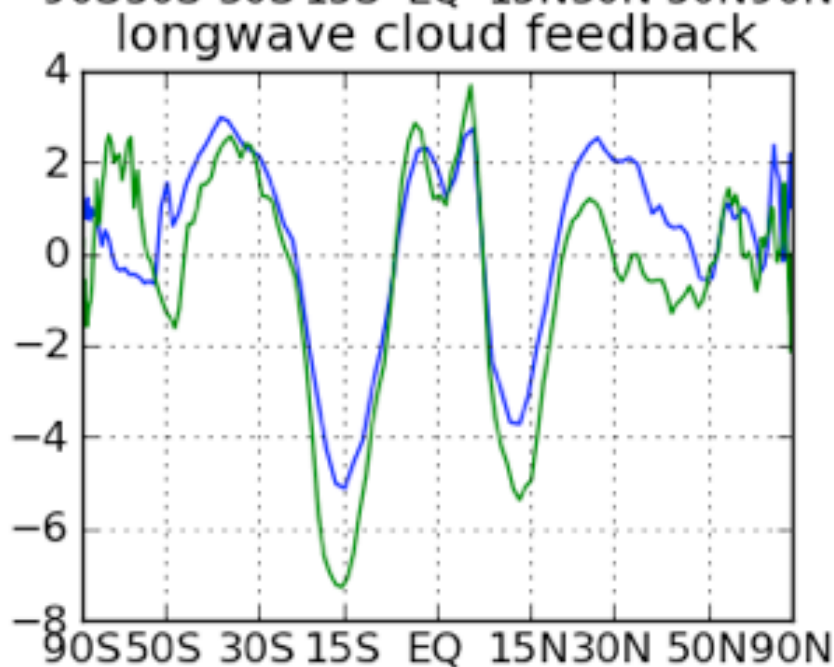
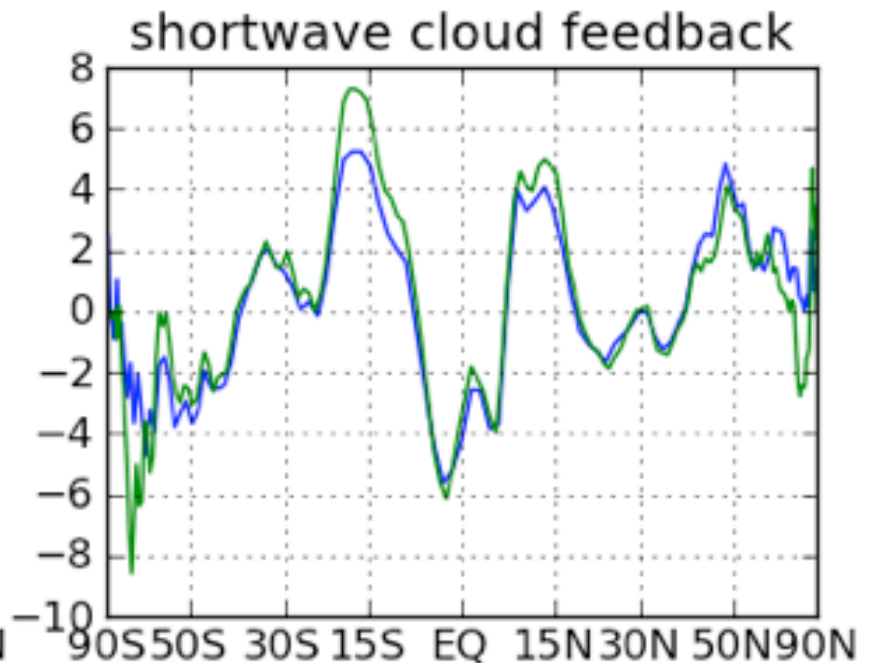
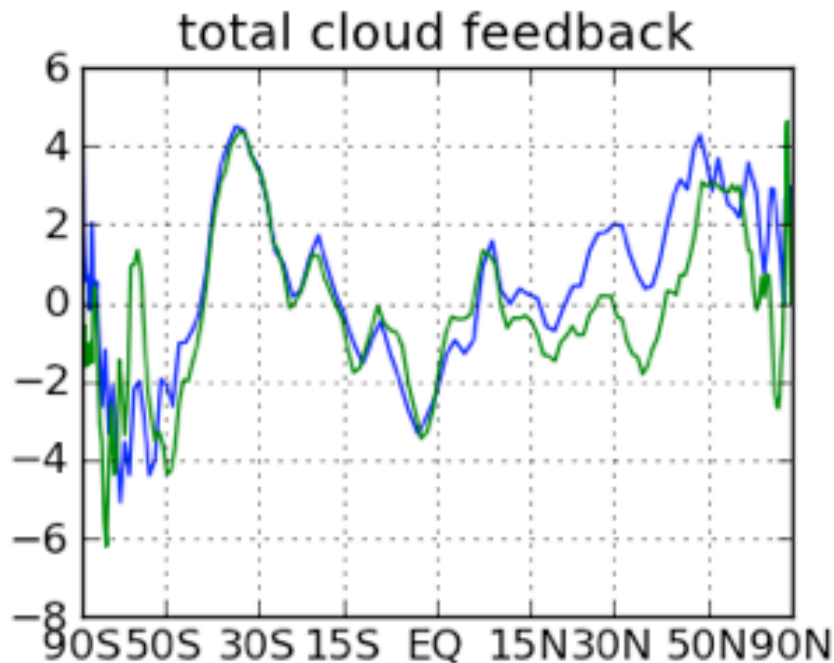


- Kernels calculated by Mark Zelinka



Cloud feedback as a
function of latitude
from the CERES data

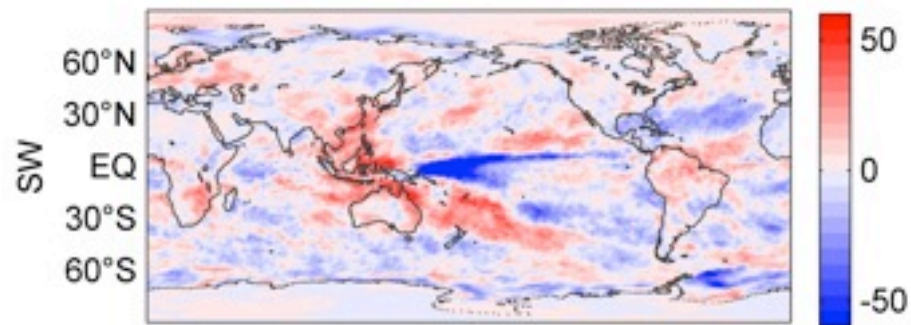
W/m²/K



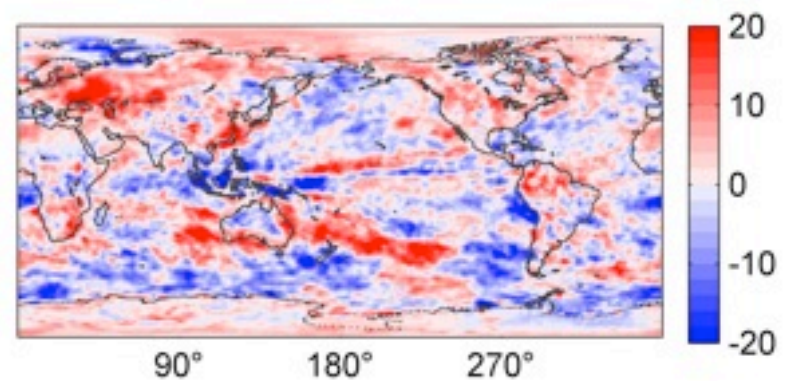
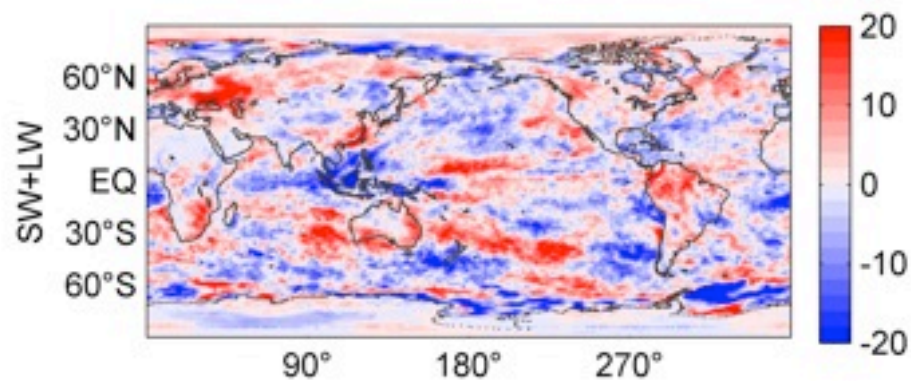
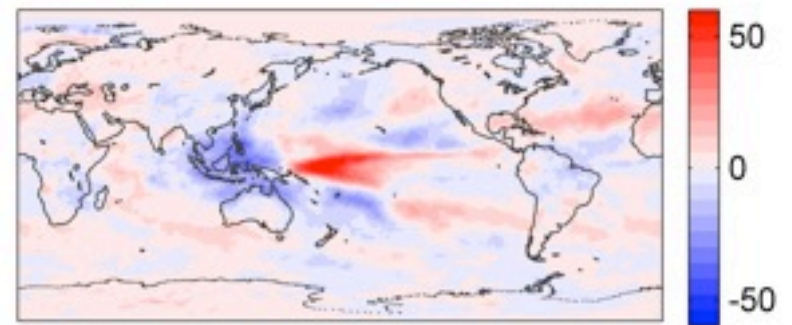
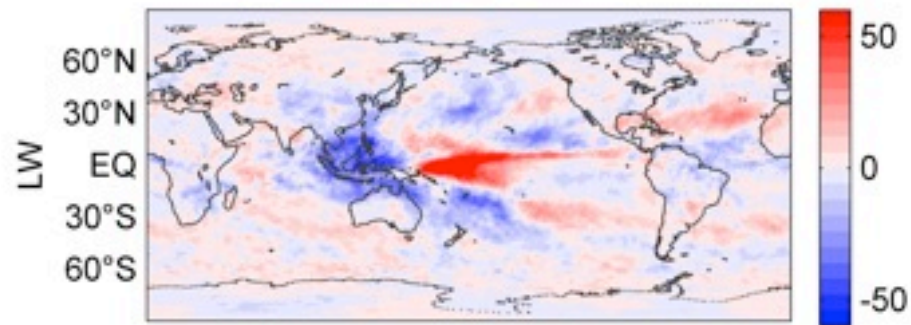
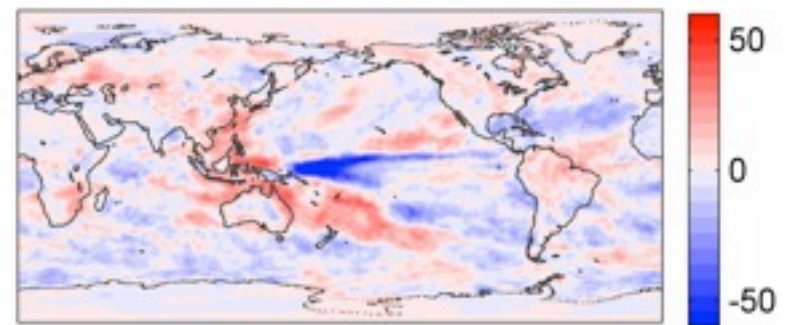
Blue: CERES
Green: MODIS

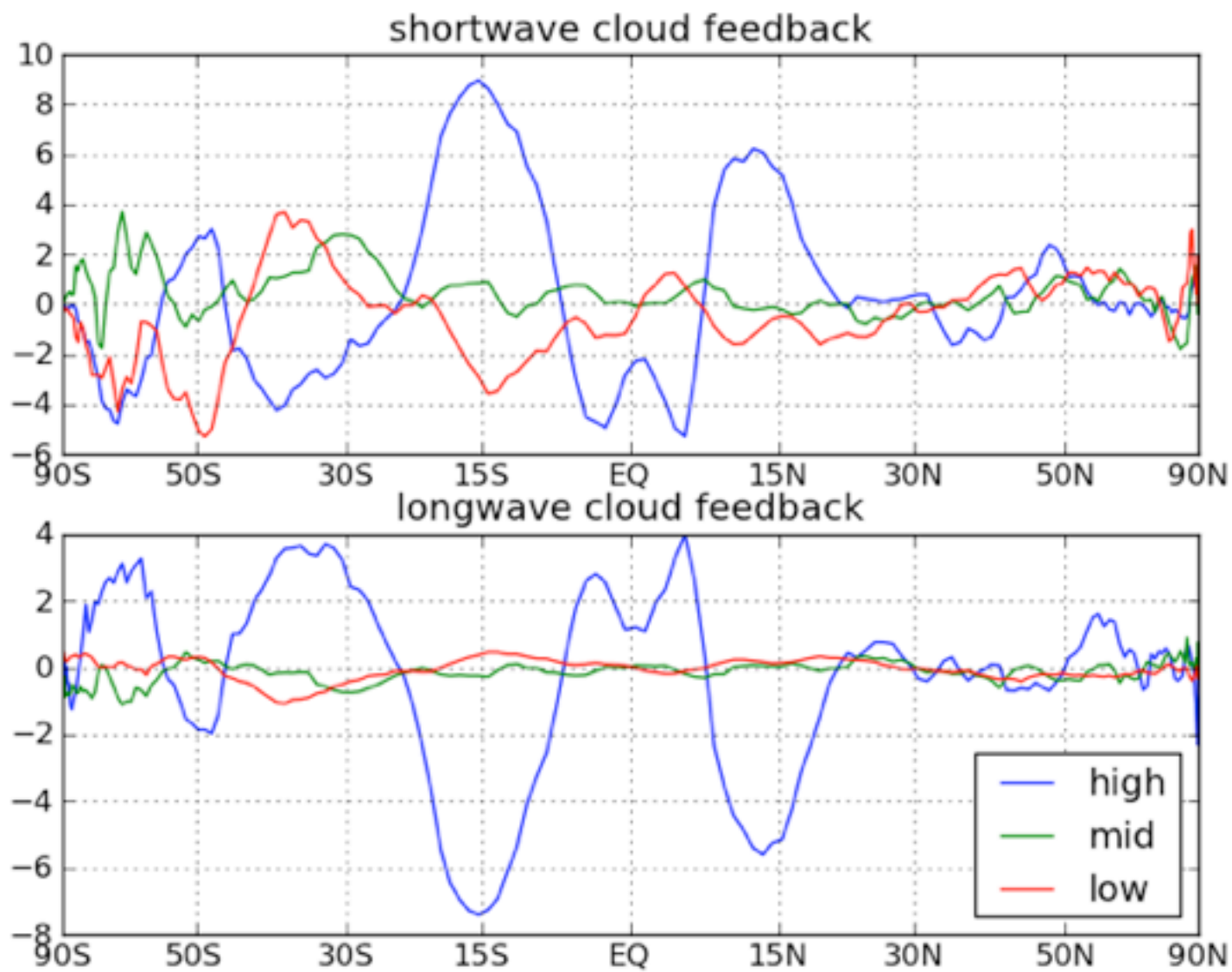
$\text{W/m}^2/\text{K}$

MODIS

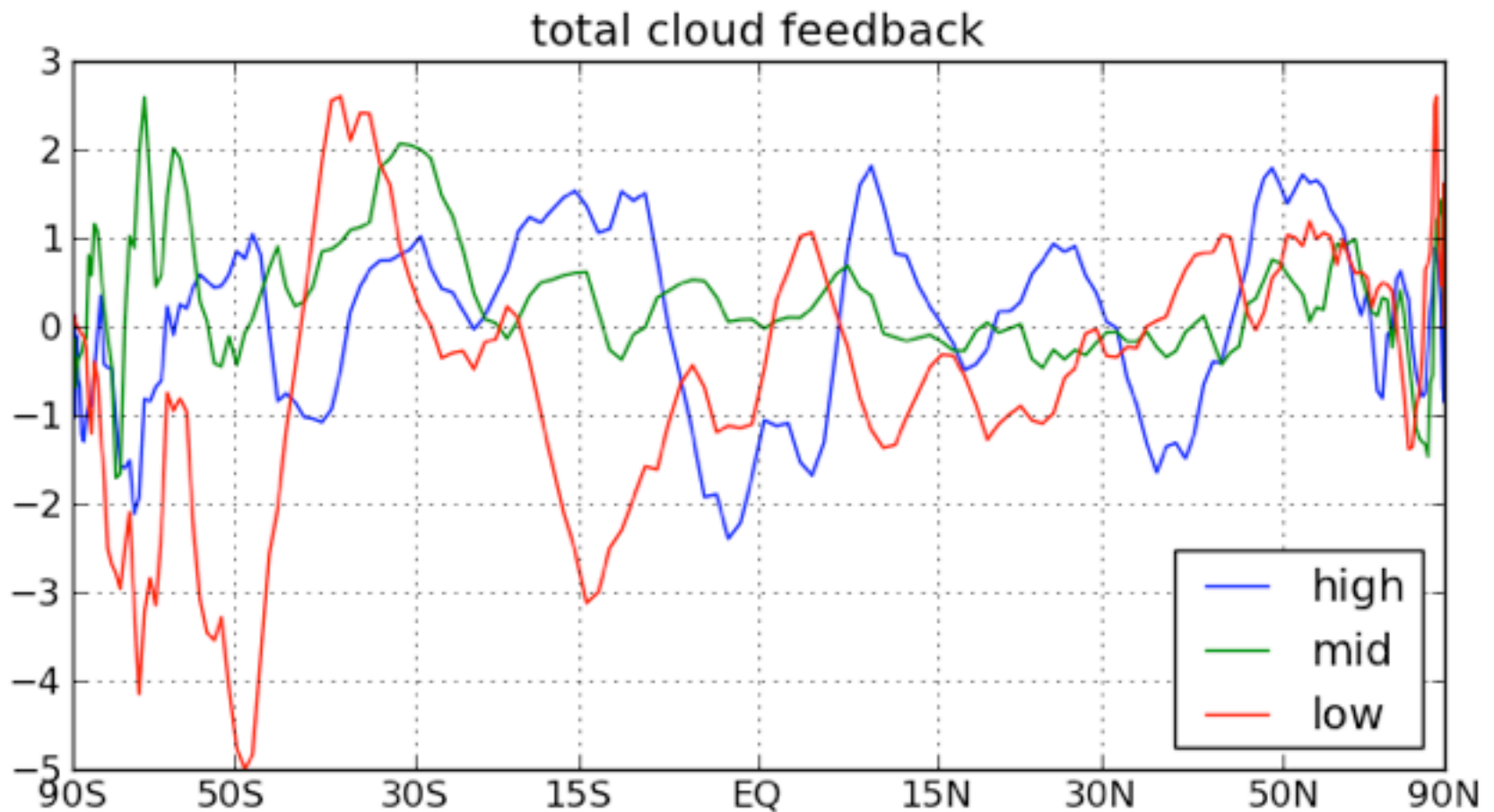


CERES

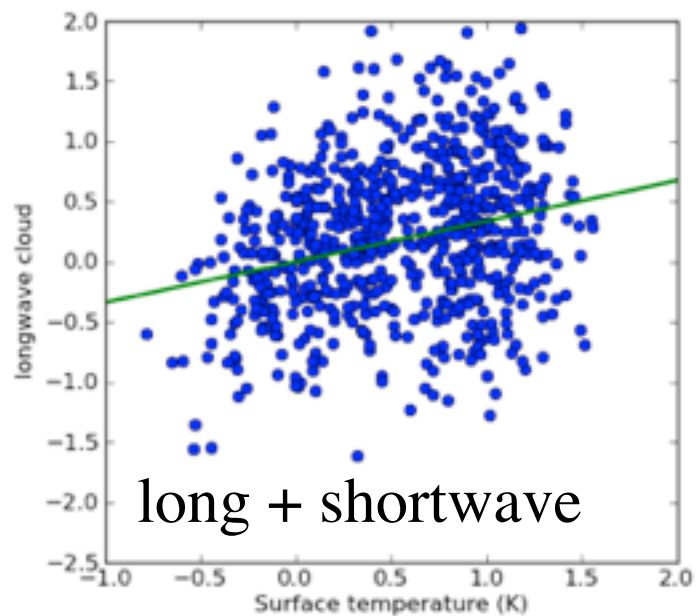
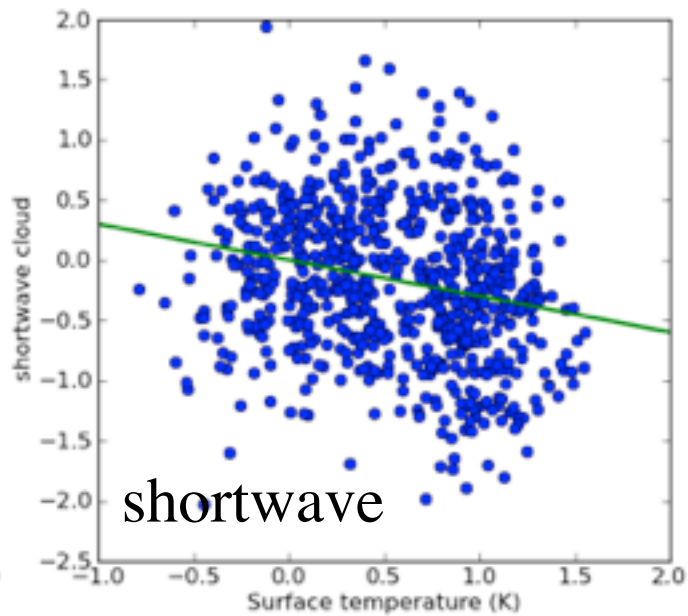
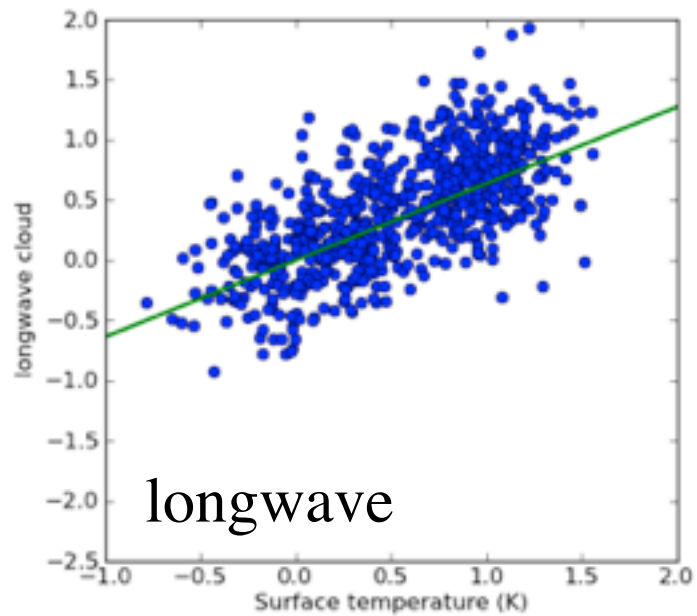




High: $P < 440$ hPa; Low: $P > 680$ hPa



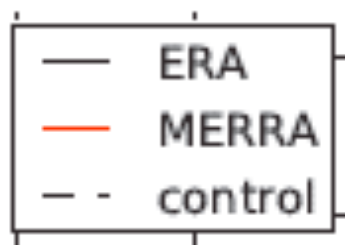
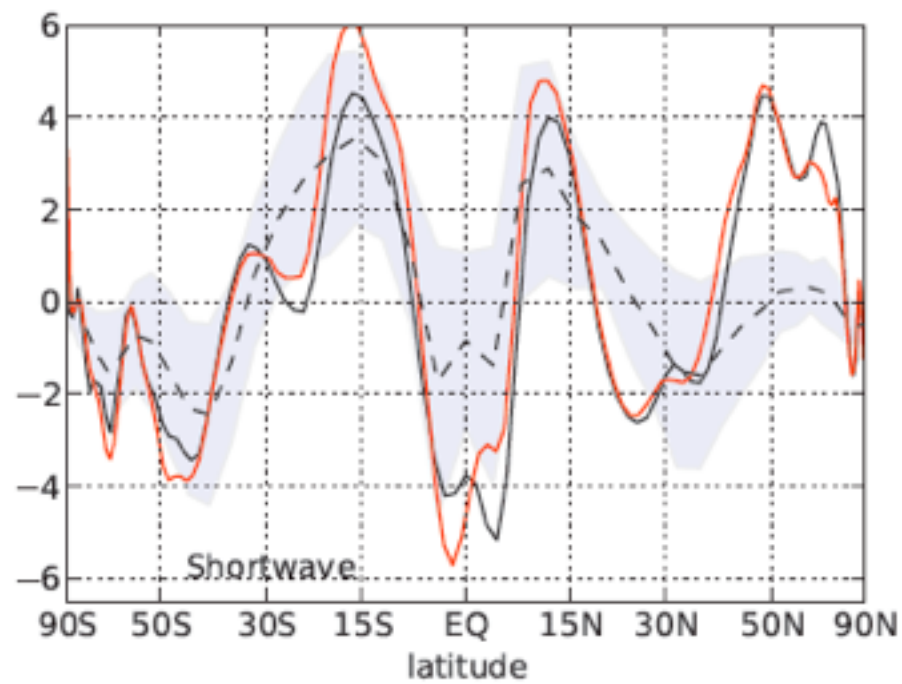
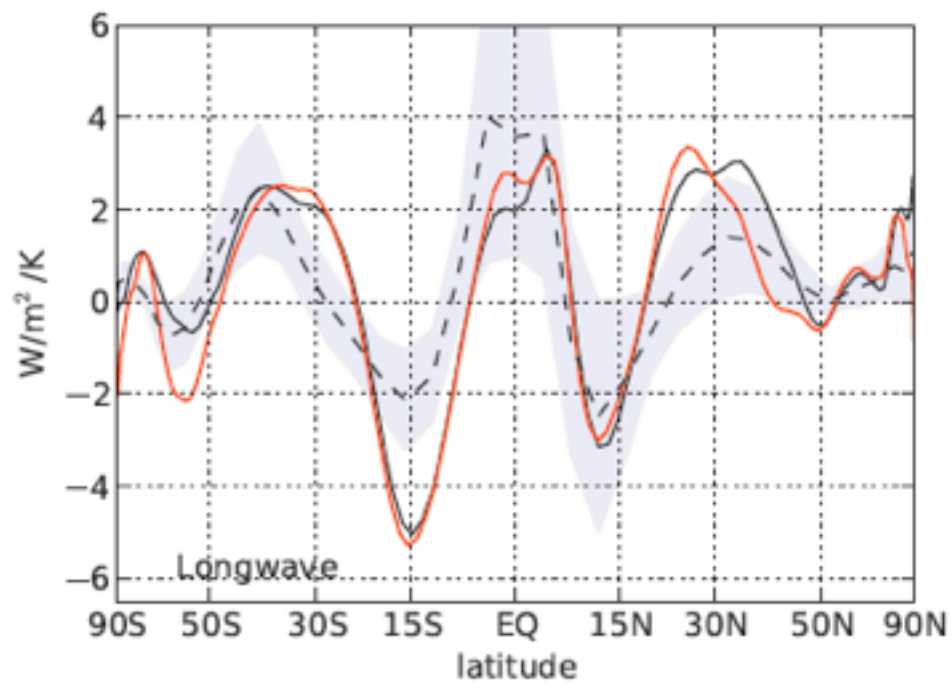
breakdown into cloud
height (low: $P > 680$ hPa,
high: $P < 310$ hPa)

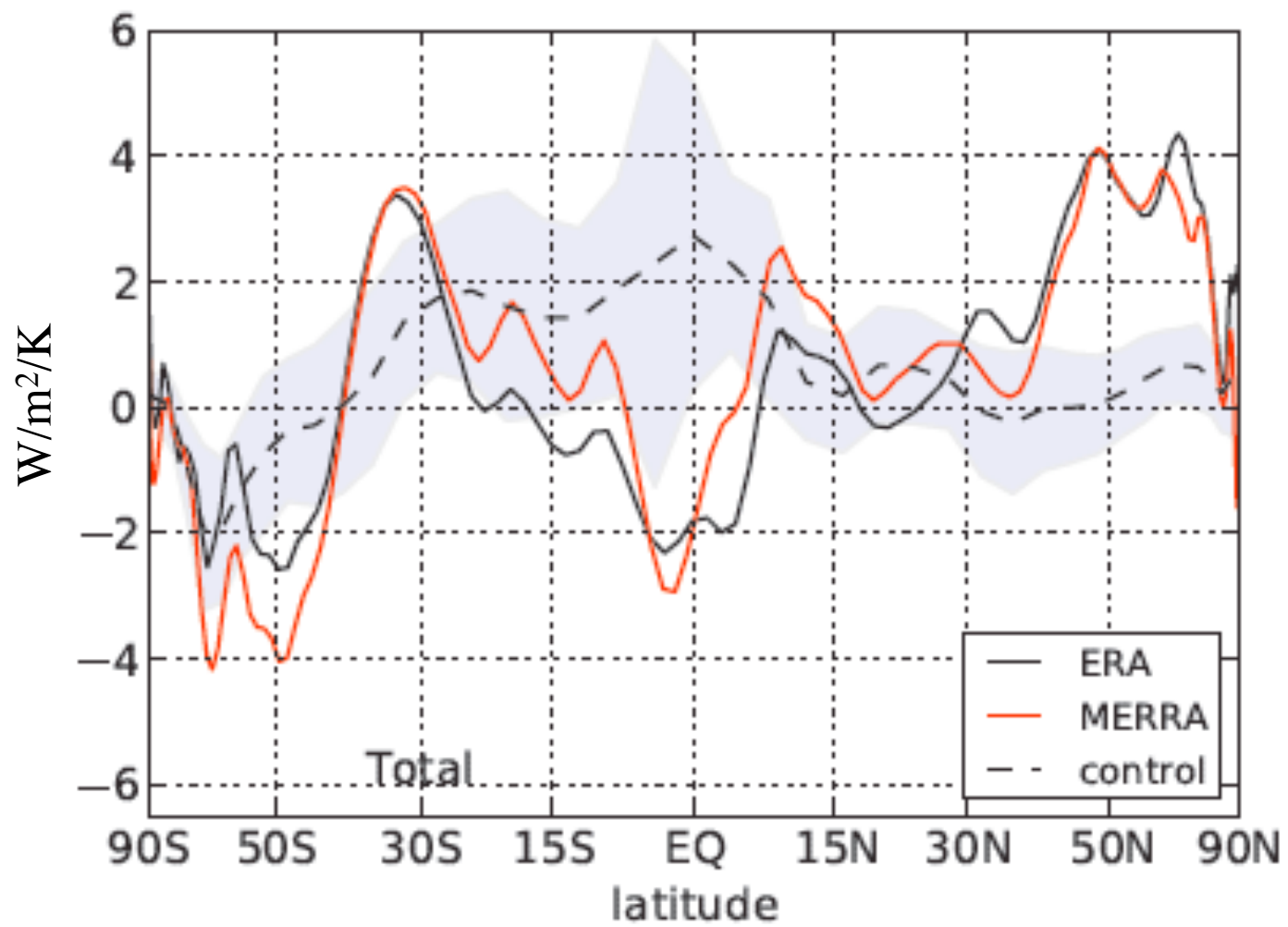


Conclusions

- *global average cloud feedback (over the last 10 years) is likely positive*
- *models show a difference in the net cloud feedback pattern*
- *good agreement between the adjusted CRF method and the cloud kernel method*
- *short and longwave cloud feedbacks are individually dominated by high clouds --- but they cancel almost completely in the net*
- *because mid- and low-level clouds do not have the same cancellation, they are important in the net feedback*







Difference between MODIS and CERES

